Quick!

We Need a Dancing Duck!

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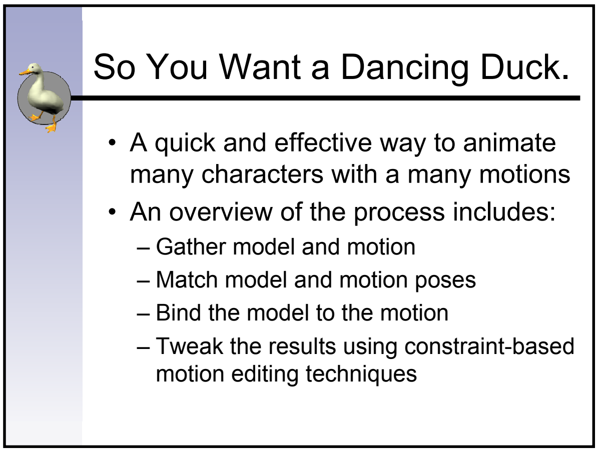
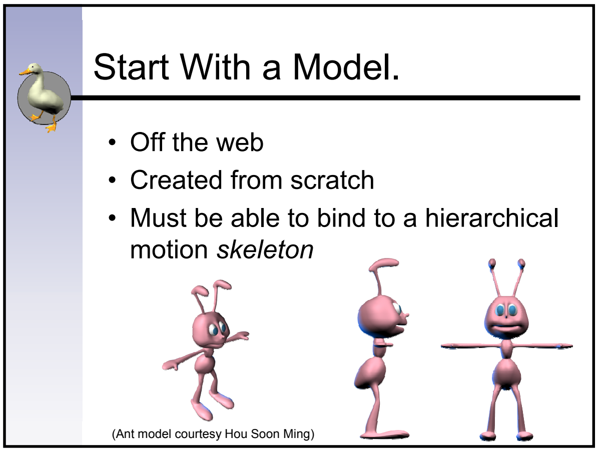
SIGGRAPH 2001 EXPLORE INTERACTION AND DIGITAL IMAGES



So You Want a Dancing Duck.

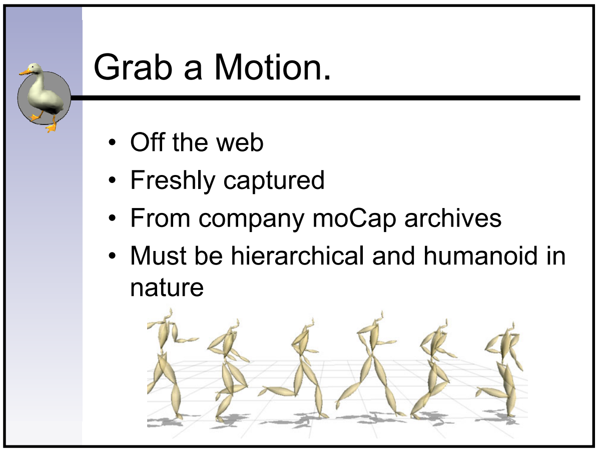
- A quick and effective way to animate many characters with a many motions
- An overview of the process includes:
  - Gather model and motion
  - Match model and motion poses
  - Bind the model to the motion
  - Tweak the results using constraint-based motion editing techniques



Start With a Model.

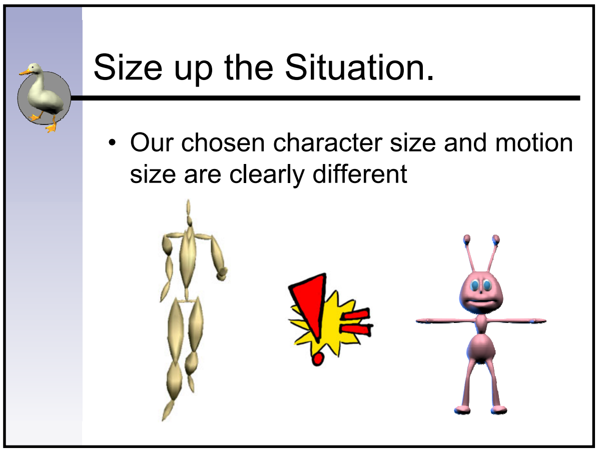
- Off the web
- Created from scratch
- Must be able to bind to a hierarchical motion *skeleton*

(Ant model courtesy Hou Soon Ming)



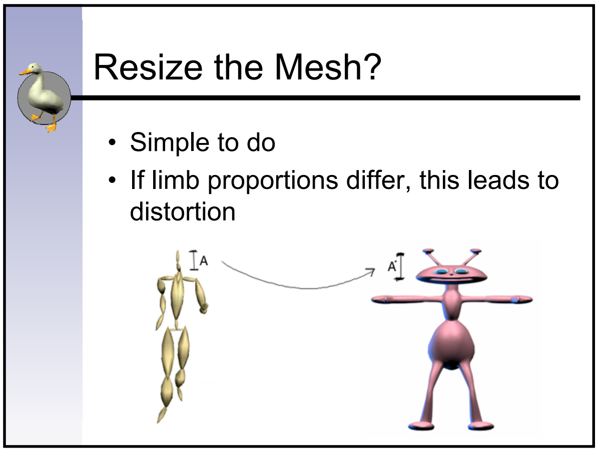
Grab a Motion.

- Off the web
- Freshly captured
- From company moCap archives
- Must be hierarchical and humanoid in nature



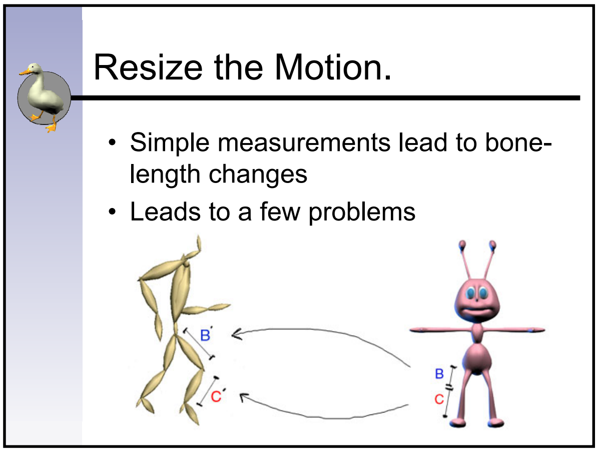
Size up the Situation.

- Our chosen character size and motion size are clearly different



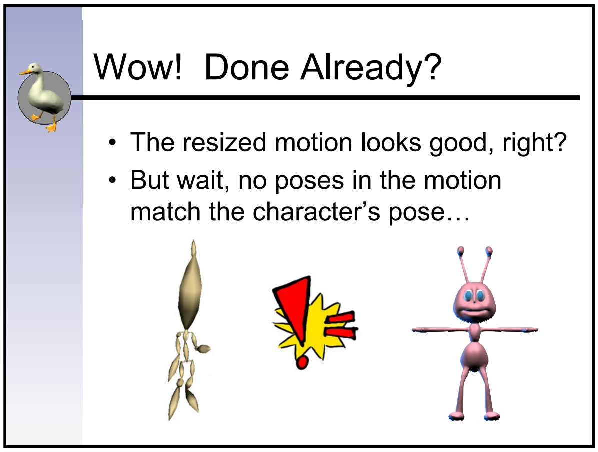
Resize the Mesh?

- Simple to do
- If limb proportions differ, this leads to distortion



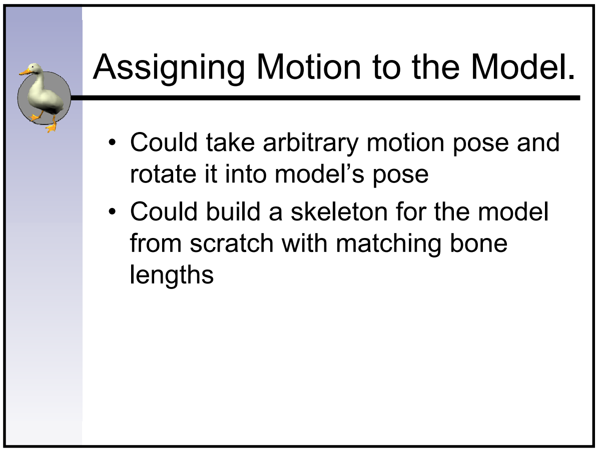
Resize the Motion.

- Simple measurements lead to bone-length changes
- Leads to a few problems



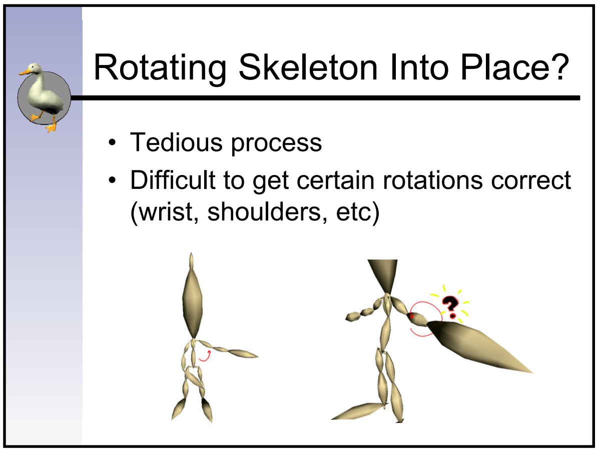
Wow! Done Already?

- The resized motion looks good, right?
- But wait, no poses in the motion match the character’s pose…



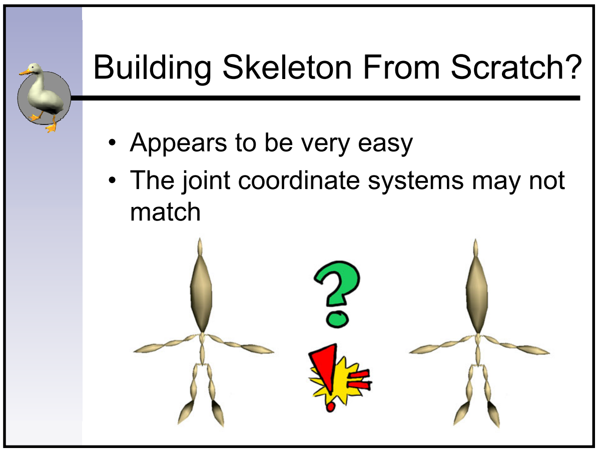
Assigning Motion to the Model.

- Could take arbitrary motion pose and rotate it into model’s pose
- Could build a skeleton for the model from scratch with matching bone lengths



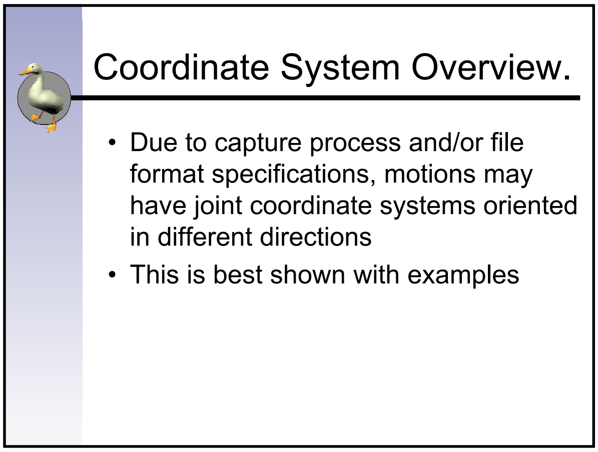
Rotating Skeleton Into Place?

- Tedious process
- Difficult to get certain rotations correct (wrist, shoulders, etc)



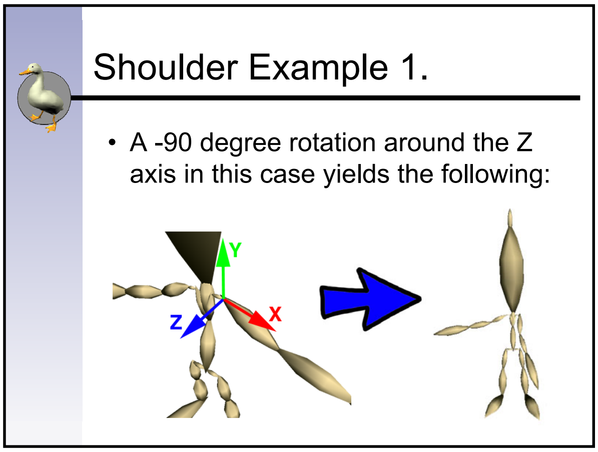
Building Skeleton From Scratch?

- Appears to be very easy
- The joint coordinate systems may not match



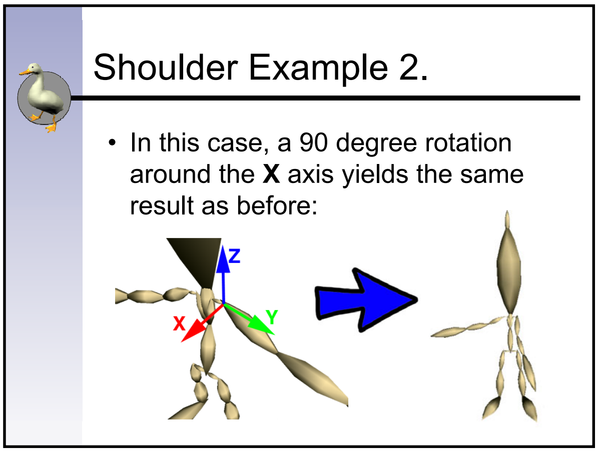
Coordinate System Overview.

- Due to capture process and/or file format specifications, motions may have joint coordinate systems oriented in different directions
- This is best shown with examples



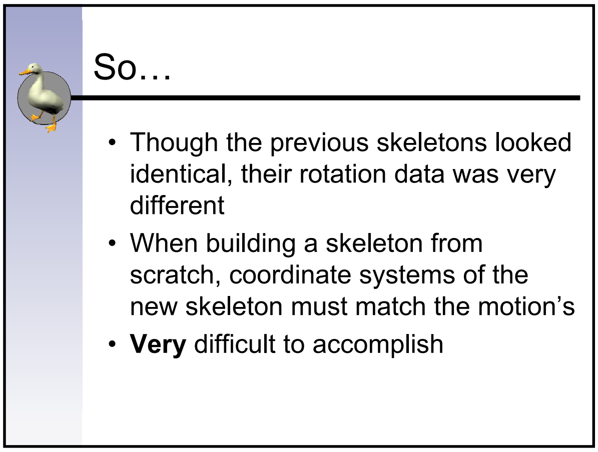
Shoulder Example 1.

- A -90 degree rotation around the Z axis in this case yields the following:



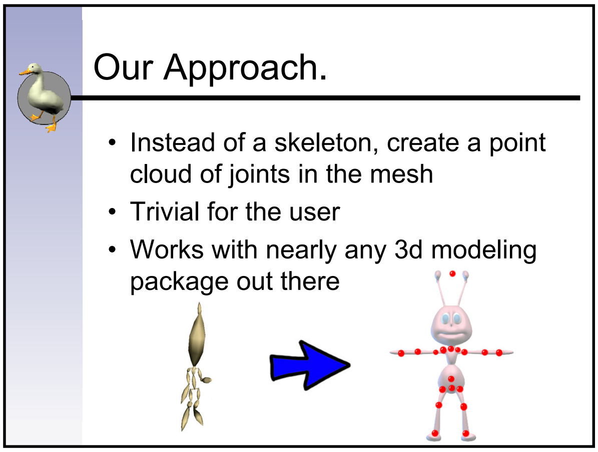
Shoulder Example 2.

- In this case, a 90 degree rotation around the **X** axis yields the same result as before:



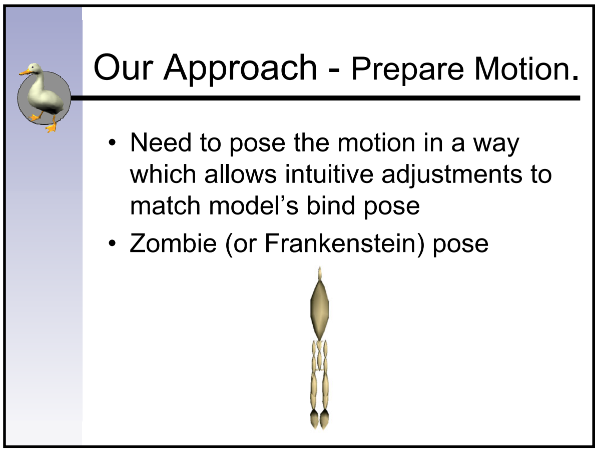
So…

- Though the previous skeletons looked identical, their rotation data was very different
- When building a skeleton from scratch, coordinate systems of the new skeleton must match the motion's
- **Very** difficult to accomplish



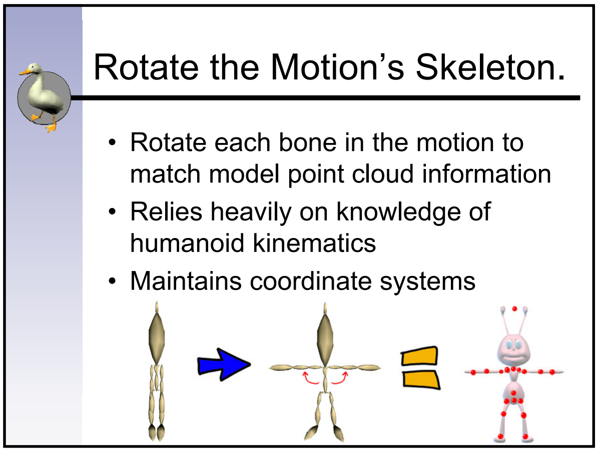
Our Approach.

- Instead of a skeleton, create a point cloud of joints in the mesh
- Trivial for the user
- Works with nearly any 3d modeling package out there



Our Approach - Prepare Motion.

- Need to pose the motion in a way which allows intuitive adjustments to match model's bind pose
- Zombie (or Frankenstein) pose



Rotate the Motion's Skeleton.

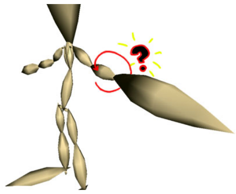
- Rotate each bone in the motion to match model point cloud information
- Relies heavily on knowledge of humanoid kinematics
- Maintains coordinate systems

Gotcha's With Our Approach.

- Heuristic relies on humanoid motion simplification
- Point cloud insufficient to convey all joint orientations
- If motion is not humanoid, humanoid kinematics do not apply

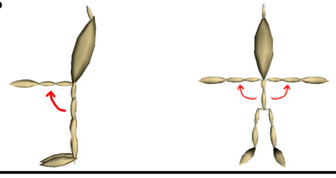
Humanoid Motion Simplification.

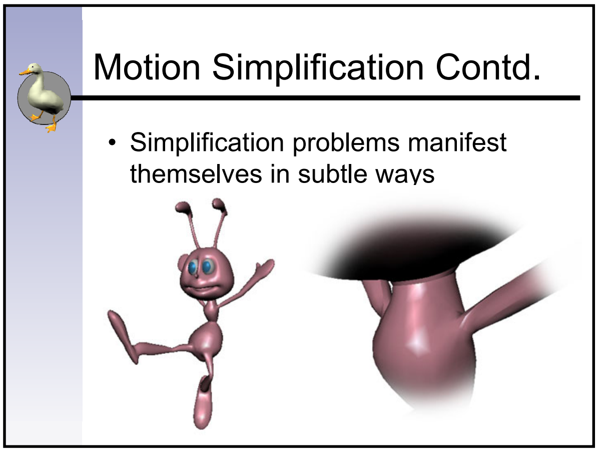
- People's joints move in very complex ways
- Example: shoulder/elbow rotation



Motion Simplification Contd.

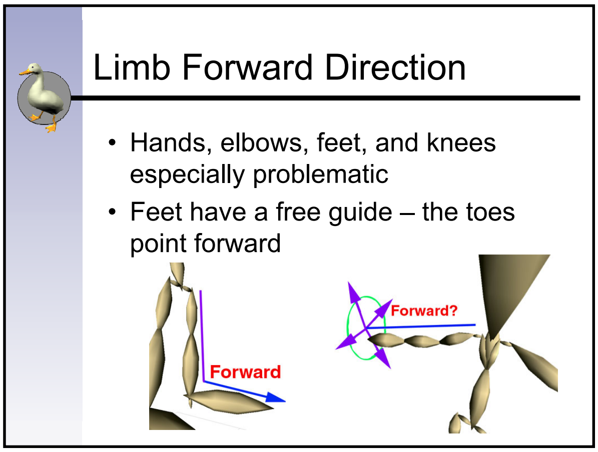
- When rotating shoulder into position, it is very difficult to take all rotational degrees of freedom into account
- We only allow for rotation around two axes





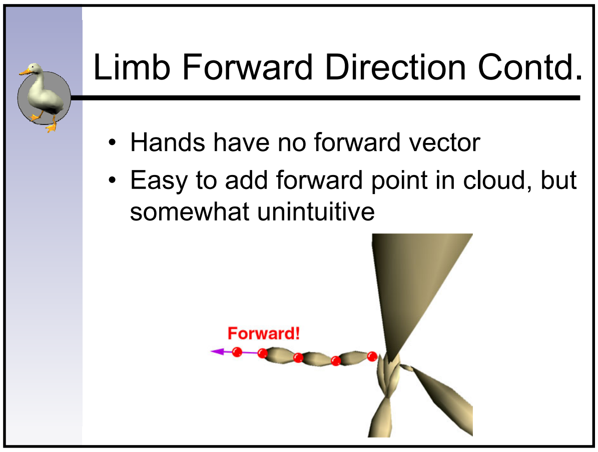
Motion Simplification Contd.

- Simplification problems manifest themselves in subtle ways



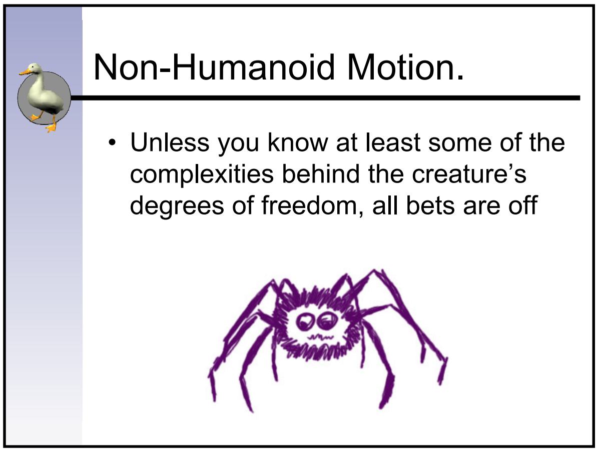
Limb Forward Direction

- Hands, elbows, feet, and knees especially problematic
- Feet have a free guide – the toes point forward



Limb Forward Direction Contd.

- Hands have no forward vector
- Easy to add forward point in cloud, but somewhat unintuitive

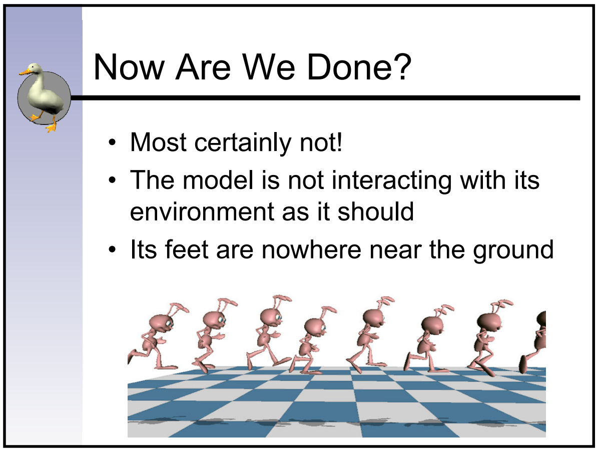


Non-Humanoid Motion.

- Unless you know at least some of the complexities behind the creature's degrees of freedom, all bets are off

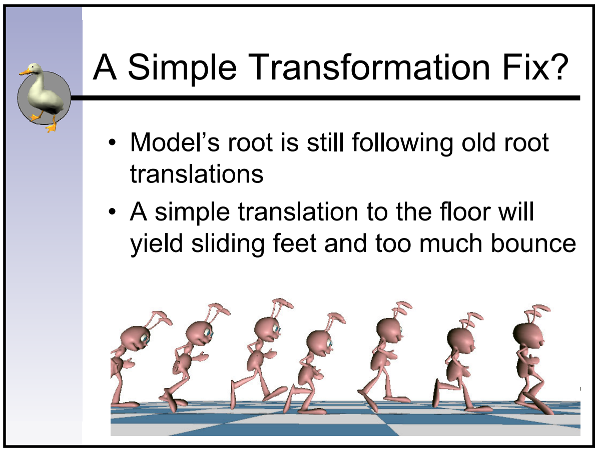
Finally We Can Bind!

- Despite all the gotcha's, our technique still works quite well
- With our matching skeletons, any bone-based hierarchical skinning technique can be applied



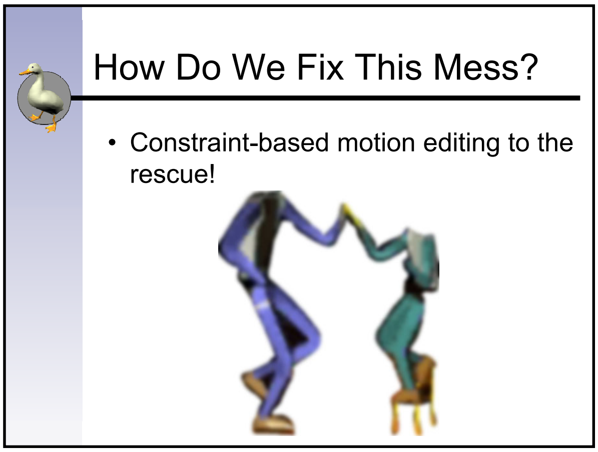
Now Are We Done?

- Most certainly not!
- The model is not interacting with its environment as it should
- Its feet are nowhere near the ground



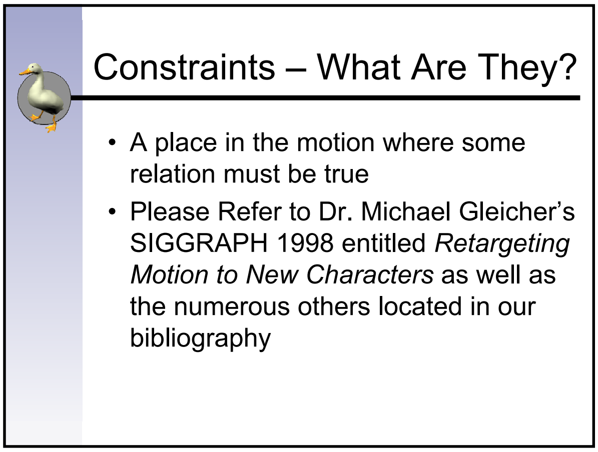
A Simple Transformation Fix?

- Model’s root is still following old root translations
- A simple translation to the floor will yield sliding feet and too much bounce



How Do We Fix This Mess?

- Constraint-based motion editing to the rescue!

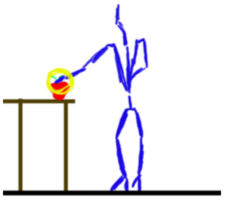


Constraints – What Are They?

- A place in the motion where some relation must be true
- Please Refer to Dr. Michael Gleicher’s SIGGRAPH 1998 entitled *Retargeting Motion to New Characters* as well as the numerous others located in our bibliography

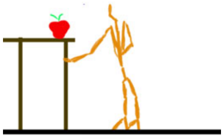
Example…

- Grabbing an apple on a table
- We place a constraint between the hand of the character and the apple



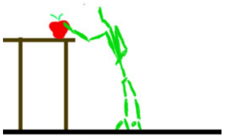
Example Contd.

- Shrinking the character, reveals that it cannot grab the apple with the same joint rotations



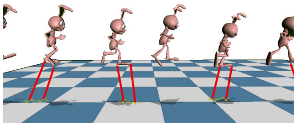
Example Contd.

- With constraints satisfied (solved for), shorter character adaptively leans and stretches to grab apple



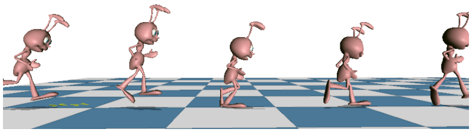
Constraints and Our Example.

- In our case, adding constraints where the motion's feet the floor would probably be sufficient
- As seen before, our new mesh is clearly not satisfying its foot-hits-floor constraints



Solving for the Constraints.

- A quick solve for the constraints yields our model walking nicely along the floor

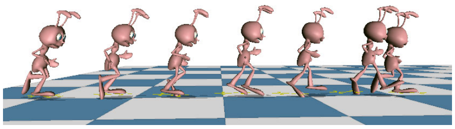


Tweaking Our Solution.

- Constraint-based motion editing is an interactive and iterative process
- Though constraints are met, motion may not be as we would like
- Further tweaking can be done

Moving Constraints.

- Moving/scaling constraints to different positions may be more desirable



Summary.

- Our approach from an artist's view :
  - Find **any** model and motion
  - Create a point cloud for the model (adding an extra point for the hands)
  - Run our pose-equating process
  - Create reasonable constraints
  - Run our constraint-solver
  - Tweak constraints until satisfied

Advantages of Our Approach.

- Coding the pose-matching portion is straightforward
- Robustness – it works with nearly every humanoid motion
- Reuse – it can breathe new life into old motions
- Speed – once system is in place, many motions can be retargeted quickly

Disadvantages of Our Approach.

- Coding an effective constraint-solver is very difficult
- Knowledge of motion's kinematics must be mastered before pose-matching can be universally effective

Special Thanks To…

- Alias|Wavefront
- ViewPoint
- Discreet
- Mainframe Entertainment
- Hou Soon Ming (http://www.its-ming.com)

…and the UW Madison
Graphics Group.

Oh, and About That Duck…

Didn't we want a dancing duck out of the deal?